El Niño and La Niña and Their Impact on the Weather In Bishop

Introduction

El Niño and La Niña episodes have been shown in numerous studies to have large scale and regional impacts on weather patterns and seasonal climate averages. This study presents the observed values of various weather parameters in Bishop in order to see what, if any, correlations there are due to El Niño and La Niña episodes on a more local scale.

Methodology

Oceanic Niño Index (ONI) values, defined as sea surface temperature anomalies in the Niño 3.4 region (located at 5ºN to 5ºS and 120º to170ºW) of the eastern and central equatorial Pacific Ocean based on centered 30-year base periods updated every 5 years, were obtained from the Climate Prediction Center (CPC) for each year since 1950 to the present. These values were analyzed for departures of 0.5°C warmer than normal for at least five consecutive overlapping three month seasons which indicated an El Niño episode and departures of 0.5°C cooler than normal for at least five consecutive overlapping three month seasons which inferred a La Niña episode for the purposes of this report. It should be noted that this criteria is also what CPC uses to define El Niño and La Niña episodes. Episodes were then defined from a July-June period for simplistic purposes for the compilation of this report.

The next step was to rate El Niño and La Niña episodes into three categories – strong, moderate and weak based on ONI values. At least three consecutive three month periods with a given value were used to rate episodes. The thresholds for rating ONI values were obtained from correspondence with CPC in a previous study on El Niño and La Niña episodes done by the author.

For El Niño episodes events were defined as:
Weak – ONI values from +0.5°C to +0.9°C
Moderate – ONI values from +1.0°C to +1.8°C
High – ONI values greater than +1.8°C

For La Niña episodes events were defined as:
Weak – ONI values from -0.5°C to -0.9°C
Moderate – ONI values from -1.0°C to -1.8°C
High – ONI values greater than -1.8°C

Data was analyzed to determine if there were any observable effects on precipitation, snowfall and temperature. For precipitation, the ‘cold season’ period of November-April (as well as December-February for precipitation) was also looked at

in order to analyze precipitation totals without any impacts from the monsoon. The December through February period was analyzed since these three months compose meteorological winter and this period often features synoptic scale storm systems that affect the Owens Valley and eastern Sierra Nevada.

Precipitation and Snowfall

The table below lists precipitation totals for the July-June period for years with an El Niño episode. In order to compute normals, totals for the 1981-2010 period were ranked from greatest to least and then split into thirds. Those values were then used to denote above normal (upper third), near normal (middle third) and below normal (bottom third). The cut-offs for these thresholds were then used as the thirty year normal for defining above normal, near normal and below normal precipitation. These cut-offs were then applied to any season that met El Niño criteria and the totals for a given season were then rated above normal (shown in green for precipitation and blue for snow), near normal (shown in black) and below normal (shown in brown for precipitation and purple for snow).

Episode	Strength of Episode	Bishop July-June Precipitation Total	Bishop July-June Seasonal Snowfall Total	Bishop November-April Precipitation Total
1951-1952	Moderate	13.52”	32.5”	13.17”
1952-1953	Weak	3.70”	1.0”	2.21”
1953-1954	Weak	5.94”	T	5.40”
1957-1958	Moderate	7.89”	2.2”	6.03”
1963-1964	Moderate	3.07”	7.9”	1.19”
1965-1966	Moderate	5.47”	T	4.07”
1968-1969	Moderate	18.02”	59.3”	16.22”
1969-1970	Moderate	2.51”	4.1”	2.10”
1972-1973	Strong	7.24”	7.0”	5.62”
1976-1977	Weak	4.69”	3.0”	1.05”
1977-1978	Weak	10.98”	6.4”	10.45”
1982-1983	Strong	10.00”	10.4”	8.07”
1986-1987	Moderate	2.10”	1.4”	0.91”
1987-1988	Moderate	4.84”	14.5”	4.14”
1991-1992	Moderate	4.20”	M	2.94”
1994-1995	Moderate	8.56”	14.0”	6.12”
1997-1998	Strong	9.92”	9.4”	7.57”
2002-2003	Moderate	3.88”	0.2”	3.82”
2004-2005	Weak	10.31”	36.3”	8.77”
2006-2007	Weak	1.51”	1.1”	0.72”
2009-2010	Moderate	5.46”	6.0”	3.45”
30 Year Normal	N/A	5.18”	6.8”	4.01”
Average for Moderate and Strong Events	N/A	7.11”	12.1”	5.69”

Overall there appears to be a good correlation for near to above normal precipitation during El Niño episodes at Bishop, with an excellent correlation during strong episodes. Snowfall, however, appears highly variable in weak to moderate events and no correlation can be made for these. Strong events appear to produce near to slightly above normal snowfall. It should be noted the snowiest winter on record in Bishop, including the largest snowstorm ever recorded here, took place during the winter of 1968-1969 which was an El Niño episode.

The table below lists precipitation totals for the July-June period for years with a La Niña episode. In order to compute normals, totals for the 1981-2010 period were ranked from greatest to least and then split into thirds. Those values were then used to denote above normal (upper third), near normal (middle third) and below normal (bottom third). The cut-offs for these thresholds were then used as the thirty year normal for defining above normal, near normal and below normal precipitation. These cut-offs were then applied to any season that met La Niña criteria and the totals for a given season were then rated above normal (shown in green for precipitation and blue for snow), near normal (shown in black) and below normal (shown in brown for precipitation and purple for snow).

Episode	Strength of Episode	Bishop July-June Precipitation Total	Bishop July-June Seasonal Snowfall Total	Bishop November-April Precipitation Total
1949-1950	Moderate	3.35”	1.7”	3.25”
1950-1951	Weak	4.69”	2.9”	3.29”
1954-1955	Weak	5.39”	21.5”	4.21”
1955-1956	Moderate	8.56”	12.8”	7.82”
1956-1957	Weak	3.69”	T	2.71”
1964-1965	Weak	2.16”	6.0”	1.50”
1970-1971	Moderate	3.39”	2.5”	2.31”
1971-1972	Weak	2.54”	1.8”	1.89”
1973-1974	Strong	6.32”	16.4”	5.98”
1974-1975	Weak	2.76”	T	1.73”
1975-1976	Moderate	3.62”	21.5”	1.49”
1983-1984	Weak	4.13”	1.0”	2.92”
1984-1985	Moderate	5.59”	9.9”	3.14”
1988-1989	Strong	2.60”	M	1.02”
1995-1996	Weak	3.09”	M	2.83”
1998-1999	Moderate	2.56”	12.1”	1.97”
1999-2000	Moderate	2.42”	T	2.04”
2000-2001	Weak	3.66”	13.1”	2.97”
2007-2008	Moderate	7.45”	M	6.46”
2010-2011	Moderate	9.13”	2.5”	7.65”
2011-2012	Weak	3.12”	4.9”	2.14”
30 Year Normal	N/A	5.18”	6.8”	4.01”
Average for Moderate and Strong Events	N/A	4.99”	9.9”	3.92”

Overall there appears to be a weak correlation for near to below normal precipitation during La Niña episodes at Bishop. Snowfall, however, appears to be near to above normal.

Temperature

The table below lists the average temperature for meteorological winter (December through February) for years with an El Niño episode. In order to compute normals, average temperatures for the 1981-2010 period were ranked from greatest to least and then split into thirds. Those values were then used to denote above normal (upper third), near normal (middle third) and below normal (bottom third). The cut-offs for these thresholds were then used as the thirty year normal for defining above normal, near normal and below normal temperatures. These cut-offs were then applied to any season that met El Niño criteria and the totals for a given season were then rated above normal (shown in orange), near normal (shown in black) and below normal (shown in blue).

Episode	Strength of Episode	Bishop Average Temperature
1951-1952	Moderate	35.5
1952-1953	Weak	40.8
1953-1954	Weak	41.1
1957-1958	Moderate	41.7
1963-1964	Moderate	39.7
1965-1966	Moderate	36.9
1968-1969	Moderate	34.2
1969-1970	Weak	40.8
1972-1973	Strong	35.7
1976-1977	Weak	41.1
1977-1978	Weak	41.2
1982-1983	Strong	40.0
1986-1987	Moderate	38.6
1987-1988	Moderate	38.0
1991-1992	Moderate	40.0
1994-1995	Moderate	40.9
1997-1998	Strong	37.6
2002-2003	Moderate	40.7
2004-2005	Weak	40.2
2006-2007	Weak	39.2
2009-2010	Moderate	37.6
30 Year Normal	N/A	39.5
Average for Moderate and Strong Events	N/A	38.4

Overall there appears to be no correlation between El Niño episodes and the average temperature for meteorological winter at Bishop.

The table below lists the average temperature for meteorological winter (December through February) for years with a La Niña episode. In order to compute normals, average temperatures for the 1981-2010 period were ranked from greatest to least and then split into thirds. Those values were then used to denote above normal (upper third), near normal (middle third) and below normal (bottom third). The cut-offs for these thresholds were then used as the thirty year normal for defining above normal, near normal and below normal temperatures. These cut-offs were then applied to any season that met La Niña criteria and the totals for a given season were then rated above normal (shown in orange), near normal (shown in black) and below normal (shown in blue).

Episode	Strength of Episode	Bishop Average Temperature
1949-1950	Moderate	38.5
1950-1951	Weak	42.0
1954-1955	Weak	34.1
1955-1956	Moderate	38.6
1956-1957	Weak	39.7
1964-1965	Weak	41.5
1970-1971	Moderate	40.0
1971-1972	Weak	38.7
1973-1974	Strong	37.3
1974-1975	Weak	39.2
1975-1976	Moderate	40.8
1983-1984	Weak	42.0
1984-1985	Moderate	37.3
1988-1989	Strong	36.3
1995-1996	Weak	41.2
1998-1999	Moderate	39.7
1999-2000	Moderate	40.8
2000-2001	Weak	37.8
2007-2008	Moderate	37.3
2010-2011	Moderate	40.8
2011-2012	Weak	39.0
30 Year Normal	N/A	39.0
Average for Moderate and Strong Events	N/A	38.9

While strong La Niña episodes appear to correlate to near or below normal temperatures for meteorological winter at Bishop, there appears to be no direct correlation for weak to moderate events.

Low Temperatures of 10 Degrees or Below

The table below lists the number of days with minimum temperatures of 10°F or below (above average years shown in blue) with an El Niño episode (July-June period).

Episode	Strength of Episode	Number of Days With Minimum Temperatures of 10 °F or Below At Bishop
1951-1952	Moderate	9
1952-1953	Weak	1
1953-1954	Weak	3
1957-1958	Moderate	0
1963-1964	Moderate	3
1965-1966	Moderate	0
1968-1969	Moderate	16
1969-1970	Moderate	5
1972-1973	Strong	7
1976-1977	Weak	0
1977-1978	Weak	0
1982-1983	Strong	0
1986-1987	Moderate	1
1987-1988	Moderate	4
1991-1992	Moderate	0
1994-1995	Moderate	4
1997-1998	Strong	3
2002-2003	Moderate	0
2004-2005	Weak	1
2006-2007	Weak	6
2009-2010	Moderate	3
30 Year Normal	N/A	3.4
Average for Moderate and Strong Events	N/A	3.6

There appears to be no correlation between El Niño episodes and the frequency of low temperatures at or below 10 degrees at Bishop.

The table below lists the number of days with minimum temperatures of 10°F or below (above average years shown in blue) with a La Niña episode (July-June period).

Episode	Strength of Episode	Number of Days With Minimum Temperatures of 10 °F or Below At Bishop
1949-1950	Moderate	10
1950-1951	Weak	0
1954-1955	Weak	17
1955-1956	Moderate	2
1956-1957	Weak	2
1964-1965	Weak	5
1970-1971	Moderate	2
1971-1972	Weak	6
1973-1974	Strong	6
1974-1975	Weak	5
1975-1976	Moderate	1
1983-1984	Weak	0
1984-1985	Moderate	10
1988-1989	Strong	13
1995-1996	Weak	0
1998-1999	Moderate	5
1999-2000	Moderate	0
2000-2001	Weak	4
2007-2008	Moderate	2
2010-2011	Moderate	0
2011-2012	Weak	5
30 Year Normal	N/A	3.4
Average for Moderate and Strong Events	N/A	4.6

Overall there appears to be a good correlation between La Niña episodes and an above normal frequency of low temperatures at or below 10 degrees at Bishop.